NFESC Project Success

# In-Situ Oxidation of Chlorinated Organic Contaminants Using Fenton's Reagent

An innovative in-situ oxidation process was recently demonstrated under the Broad Agency Announcement (BAA) through the Navy's Y0187 programs. The project was managed by a joint partnership between SOUTHDIV and NFESC and has been designed to cleanup site soils and groundwater contaminated by chlorinated hydrocarbons.

**Project Summary -** Under the NAVFAC Y0187 technology demonstration program, which is managed by NFESC. SOUTHDIV proposed in-situ chemical oxidation using Fenton's Chemistry method as a means to reduce high source area concentrations of chlorinated hydrocarbons in groundwater. Such source reduction enhances the efficiency of natural attenuation processes, is consistent with EPA guidance, and helps ensure regulatory acceptance of monitored natural attenuation for remaining residual concentrations.

The site selected for the demonstration project is located at NAS Pensacola, Florida. Groundwater at the site has chlorinated hydrocarbon contamination at levels of up to 3000 ppb. A natural attenuation assessment with quarterly sampling for two years was recently completed by SOUTHDIV with the support of the USGS. The results indicated that natural attenuation was protective of Pensacola Bay, the closest receptor. However, SOUTHDIV planned substantial source reduction at the site to meet regular concerns and to accelerate site closeout. The source area targeted by the demonstration project was fairly discrete, an area approximately 80-foot by 30-foot area, 5 feet thick (35 to 40 feet below land surface).

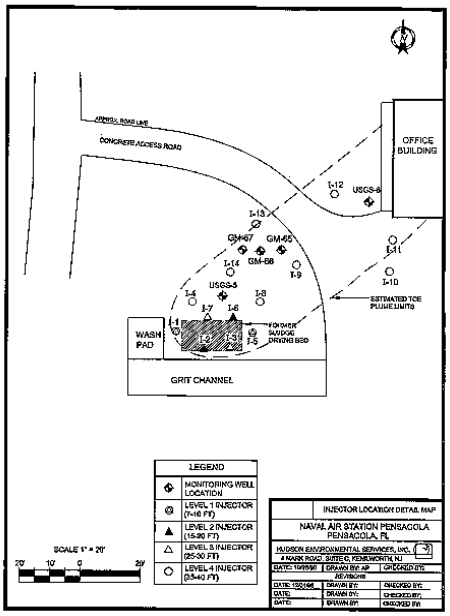
Geo-Cleanse International, Inc. (GCI) was selected by SOUTHDIV from the BAA list of innovative technology vendors maintained by NFESC to demonstrate the oxidation process method for removal of Trichlorethylene (TCE) and related degradation products in site soil and groundwater.

The actual in-situ chemical oxidation is driven by formation of a hydroxyl free radical via Fenton's Reactant Chemistry. This methodology for the treatment of organic compounds was first introduced in the 1890's' by H. J. Fenton and has been widely studied, utilized, and proven effective by the wastewater industry. The Fenton's reaction is shown below:

$$H_2O_2 + Fe^{+2} \rightarrow OH\bullet + OH^- + Fe^{+3}$$

| Hydrogen Peroxide | Ferrous Iron | Hydroxyl Radical | Ferric Ion |
|---|---|---|---|

The combination of hydrogen peroxide and the catalyst ferrous iron produces the hydroxyl free radical OH•. This radical is an extremely powerful oxidizer of organic compounds. In the Fenton's Reactant in-situ method, hydrogen peroxide and trace quantities of metallic salts are injected into the subsurface using an innovative




NAS Pensacola, demonstration site

Equipment trailer

*Goals for the demonstration:*

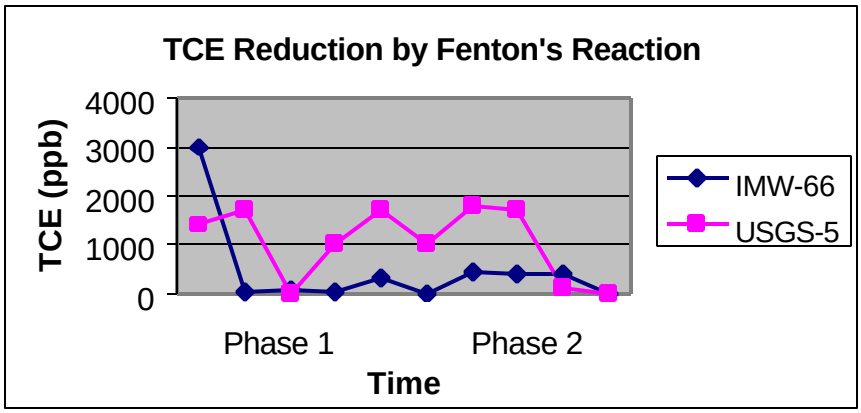
- *Create free-radicals in in the subsurface to oxidize chlorinated hydrocarbons.*
- *Establish an effective radius of influence from each injector.*
- *Monitor the effectiveness and economy of the process.*

pressurized injection technique. The oxidation process ultimately converts chlorinated organics to carbon dioxide, water, and chloride ions. The residual hydrogen peroxide rapidly disassociates into oxygen and water. Soluble iron amendments added to the aquifer during injection are precipitated out during the conversion to ferric iron.

**Field Demonstration Phase -** The field demonstration injection of Fentons's reagent was performed during Phase I and II injection periods. Each injection period lasted one week.

During the Phase I demonstration, 4000 gallons of hydrogen peroxide and 4000 additional gallons of ferrous sulfide, were injected into 14 wells. The wells varied from 10 to 40 feet in depth and were installed with a hollow stem auger. Analyses were performed for TCE and its degradation products. During the subsequent Phase II demonstration, the injection quantities were increased to 6000 gallons each and targeted primarily at the 35 foot to 40 foot depth where the highest concentrations of chlorinated hydrocarbons had accumulated over a clay confining layer.

The on-site equipment allowed for injection of 50% strength hydrogen peroxide, ferrous sulfide, buffering agents, and compressed air simultaneously into four wells using an innovative injection well design.




**Project Successes** - The results of the technology demonstration are very promising. During Phase I, the oxidation process was able to reduce total organic hydrocarbons in the monitoring wells from as high as 3000 ppb to 130 ppb. Analysis of groundwater samples taken one month after injection indicated a rebound in contaminant levels to 485 ppb, therefore the second Phase II treatment was performed. The second round on injection successfully reduced the chlorinated hydrocarbons to close to detection levels with no rebound measured one month later. Based upon the successful source reduction, SOUTHDIV is preparing a revised Corrective Action Plan to propose monitored natural attenuation as the final polishing remedy in a modified RCRA permit.

**Lessons Learned -** The Fenton's Reagent oxidation process was demonstrated to be a simple, safe, fast, and effective in-situ treatment method for chlorinated hydrocarbons like TCE. For the small, discrete source area at NAS Pensacola, the technology was very cost-effective. For larger treatment applications, the cost-effectiveness may be diminished and should be compared with other technologies. The site at NAS Pensacola had nearly ideal conditions for the demonstration. These included sandy silt soils with relatively high hydraulic conductivity, low carbonate/bicarbonate content, and low pH. Use of the technology at other sites should be evaluated based on site-specific hydrogeologic and geochemical conditions.

Injection well head with compressed air, catalyst, and hydrogen peroxide injection.

Injection into 4 wells heads simultaneously

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